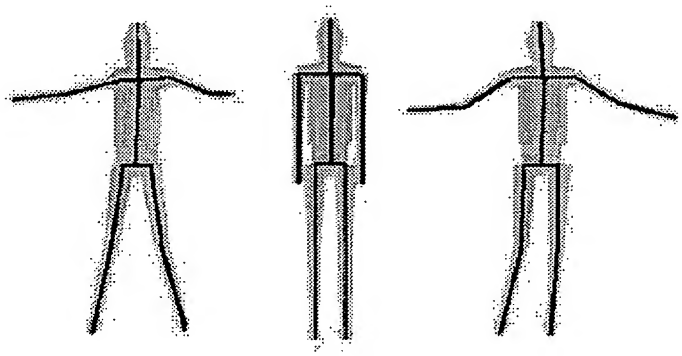
# Human Body Tracking with Articulated Human Body Model

*with Ram Nevatia, Isaac Cohen, Soon Ki Jung, with contributions from Hongxia Li, Xuefeng Song and Tao Zhao.*

The objective of this research is to develop techniques for tracking human body and estimating human pose. This has many applications in video surveillance, motion capture for animation and human-computer interaction. The challenge is to develop a vision-based human body tracking system that can handle a wide range of human movement; a system that is accurate, robust and efficient.

## Human Articulated Body Model



The articulated human body model we use consists of 10 joints and 14 segments, representing the head, torso and limbs. Each segment is represented by a tapered 3D cone with an elliptical cross-section. The model has 32 degrees of freedom that include the global translation, rotation and scale, and local joint rotations.

## Body Parts Detection

Using a component-based approach, we detect different body parts using simple computer vision techniques.

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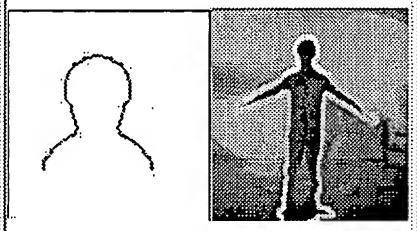
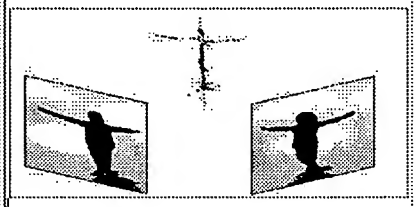
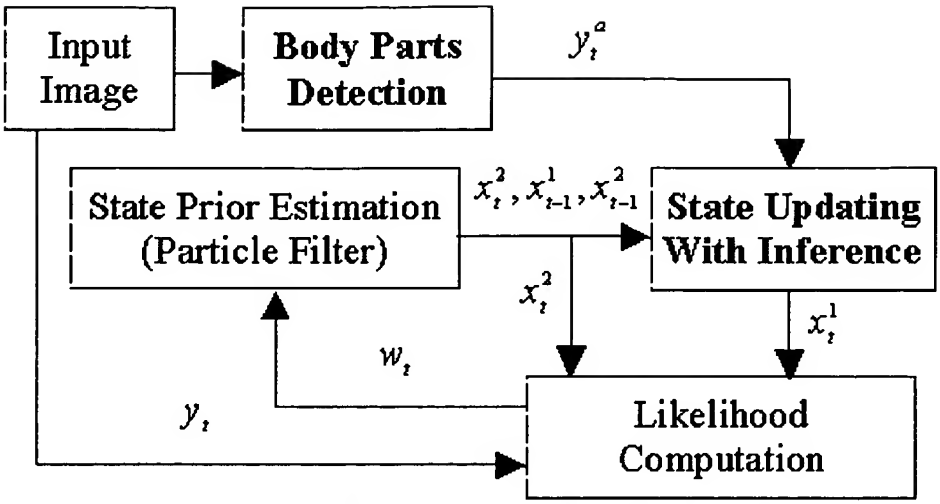
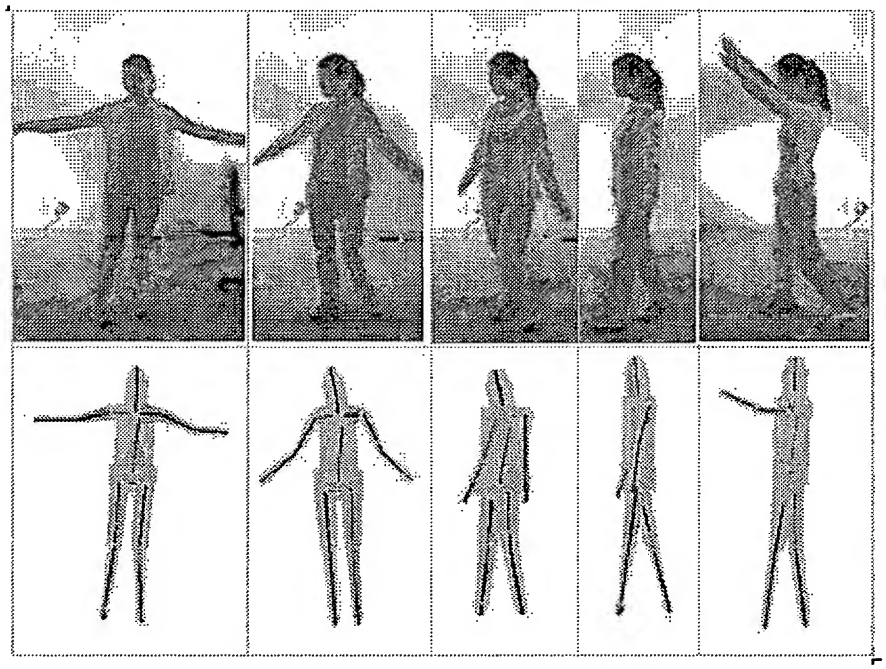
| **Hand Detection** | | The hands are detected along the outlines of the foreground. Peaks of convex curvature are extracted along the silhouette boundary. We match these curvature peaks in different images using epipolar constraints, and reconstruct their 3D positions. Using prior estimation of the hand positions, based on human body structure and tracking information, we can further eliminate unlikely hand positions. |
| **Head Detection** |  | The head detection is performed using a reference chain code representation of a head-shoulder contour as a template for head. We match this template along the contour boundary of the extracted silhouette to detect the head. To achieve scale invariance, the contours are rescaled with respect to the estimated human height. The chain code features are normalized before comparison to achieve rotation invariance. Matching error is based on chain code differencing. |
| **Torso Orientation** |  | A simple method is used to extract the main axis of the torso. We first extract the medial axis of the 2D silhouettes. The medial axis points in different views are matched using epipolar constraint, and the 3D positions computed. A line is then fitted to these 3D points using PCA and RANSAC method. This extracted line provides a measurement of the torso orientation, and a constraint that the torso must lay along the line. |

## Particle Filter with Analytical Inference

We proposed a method for combining particle filter with analytical inference techniques. The analytical inference is provided by body parts detection, and is used to update subsets of state parameters representing the human pose. This additional inference is used to improve the state estimation within the particle filtering framework. This new method has the advantage of handling track initialization, recovering lost track, and reducing the computational load.



**For more details:**

- Mun Wai Lee, Isaac Cohen, Soon Ki Jung, "Particle Filter with Analytical Inference for Human Body Tracking," *IEEE Workshop on Motion and Video Computing*, 2002. [pdf] [Video].
- Isaac Cohen, Mun Wai Lee, "3D Body Reconstruction for Immersive Interaction," *Second international Workshop on Articulated Motion and Deformable Objects* Palma de Mallorca, Spain, 21-23 November, 2002. [pdf]

*Project is ongoing, please send me any comment and suggestion.*